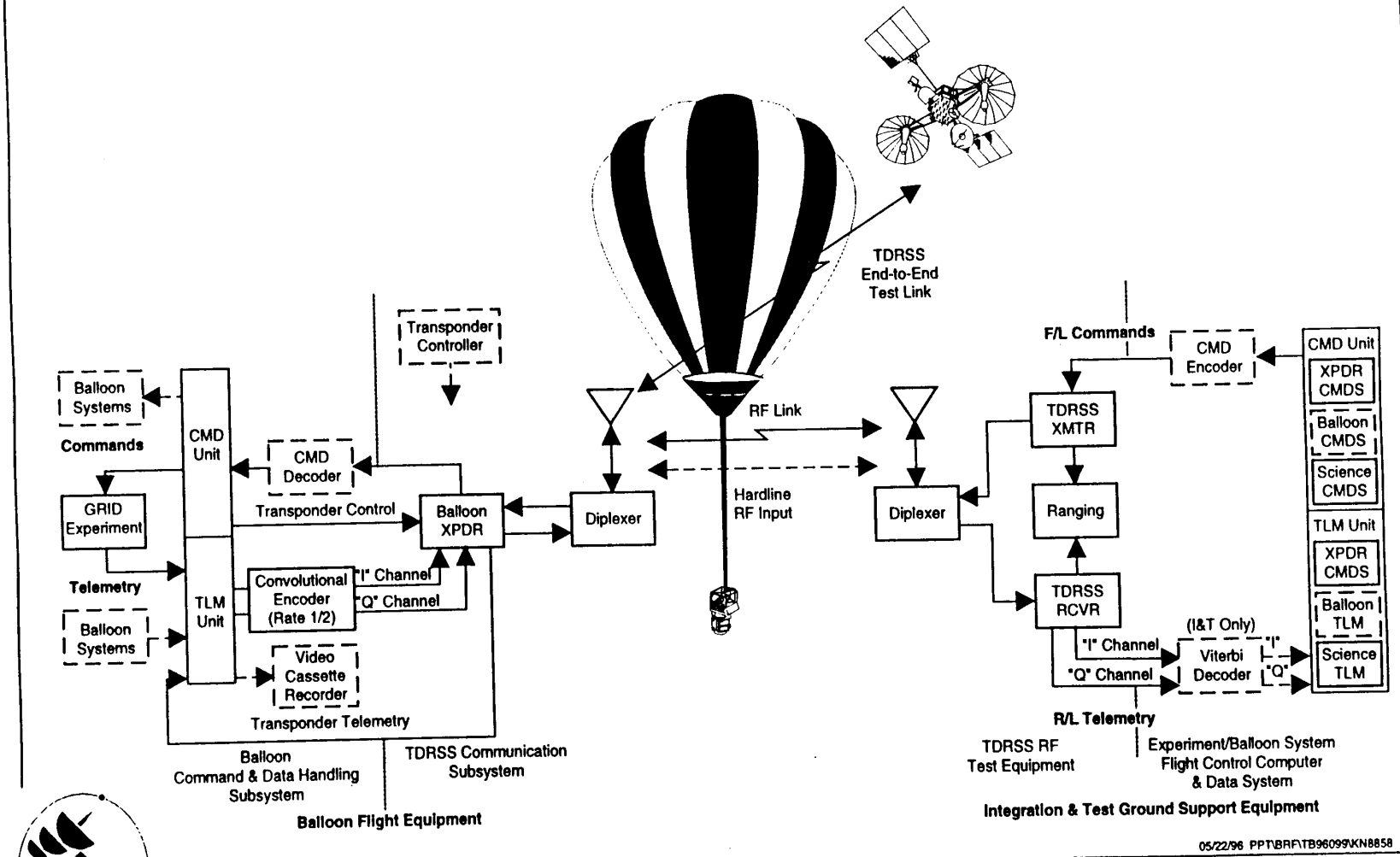
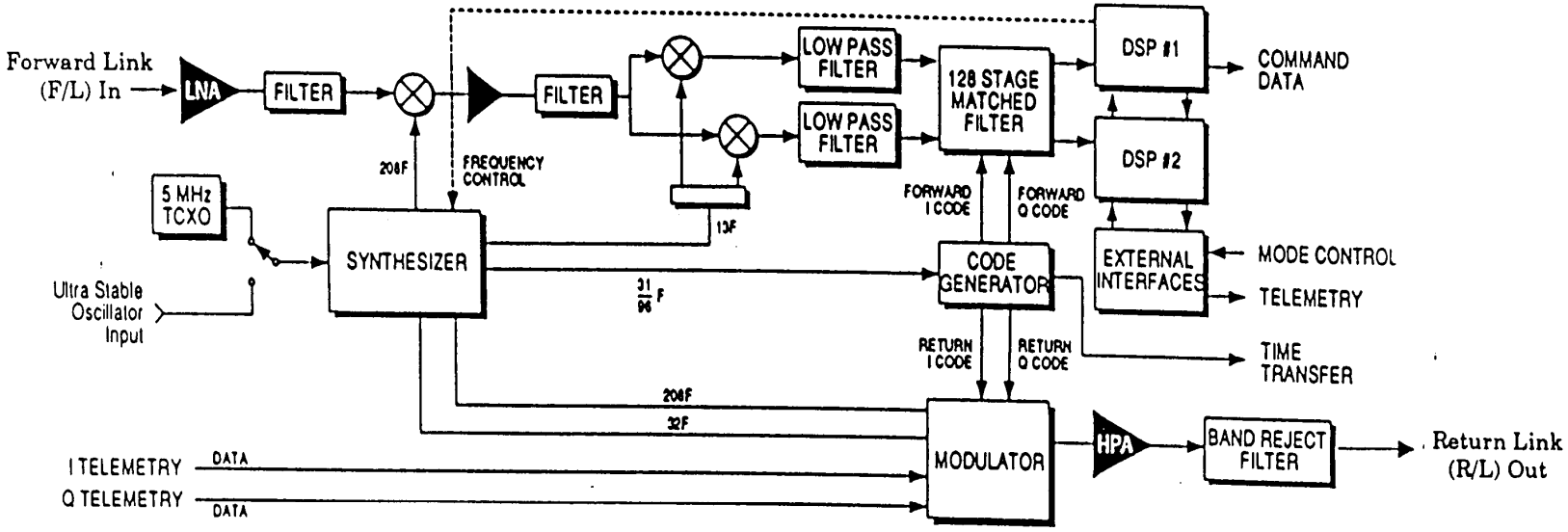
Long Duration Balloons

- GSFC/Code 531 (under sponsorship of the Code O Advanced Systems Program) managed the development by Stanford Telecom of a non-space-qualified, balloon-class TDRSS user transponder for the Wallops LDBP
- Code 531 also developed a quadrifilar helix flight antenna and a transportable set of RF test equipment (TURFTS) for the LDBP
- Successful flight tests of the TDRSS communications hardware were conducted in September 1993 and August 1994

Balloon Flight/TDRSS User (CCD-Based) Transponder System



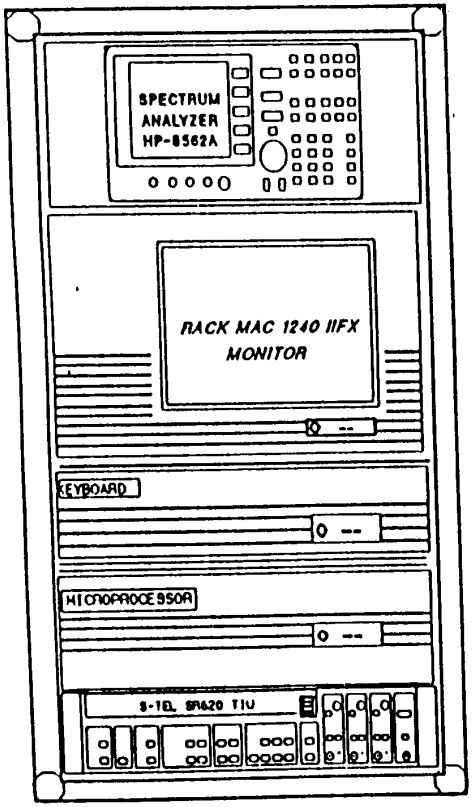
Balloon-Class TDRSS User Transponder Block Diagram



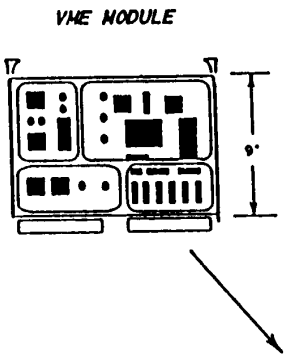
- PN code acquisition times < 2.2 seconds at threshold
- Acquisition possible with data modulation (data rates up to 24kbps)
- Statistical forward link data quality monitor
- Reduced power consumption

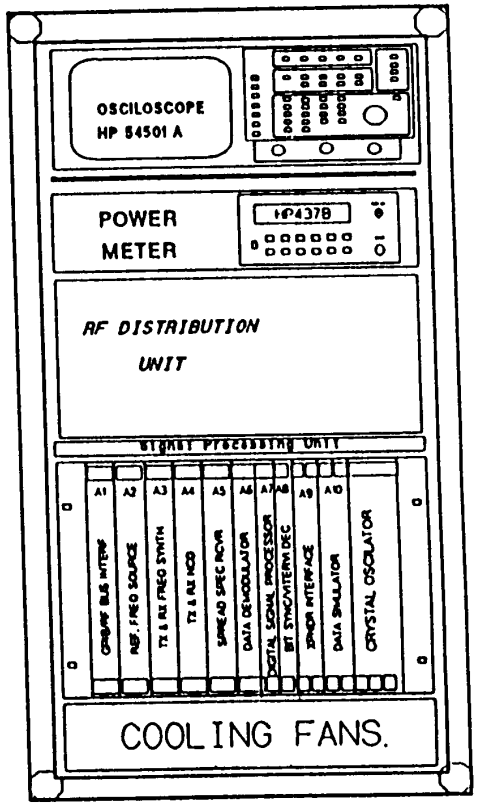
Transportable TURFTS for LDBP

TURFTS HARDWARE



RACK A1





RACK A2

Technology Description:
Fourth Generation TDRSS User Transponder

Description

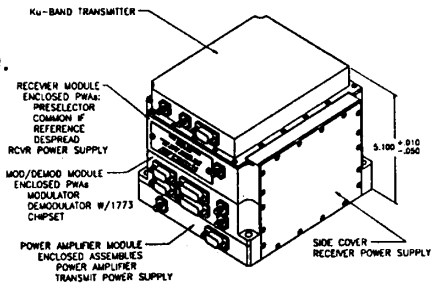
- Small, light-weight and low-power dual-mode (TDRSS/GN) transponder with high rate command and telemetry capabilities and improved and more standardized interfaces
- Development sponsored by NASA HQ/SOMO and managed by GSFC (contracts with CE and Motorola)

Maturity

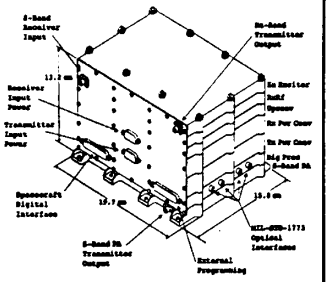
- Engineering Models to be completed November 1997, protoflight and flight units delivery in late 1998
- Users include GP-B, EOS-PM and MIDEX-MAP.

Objectives and Benefits

- To promote the use of TDRSS, especially within the small satellite community
- To reduce the weight and power burdens placed on user satellites by previous generations of TDRSS user transponder
- High data rate capabilities reduce transmission time.
- Standardized interfaces reduce integration time
- Fast acquisition time permits Demand Access operation
- Dual sources will reduce the cost of flight units



CE Unit

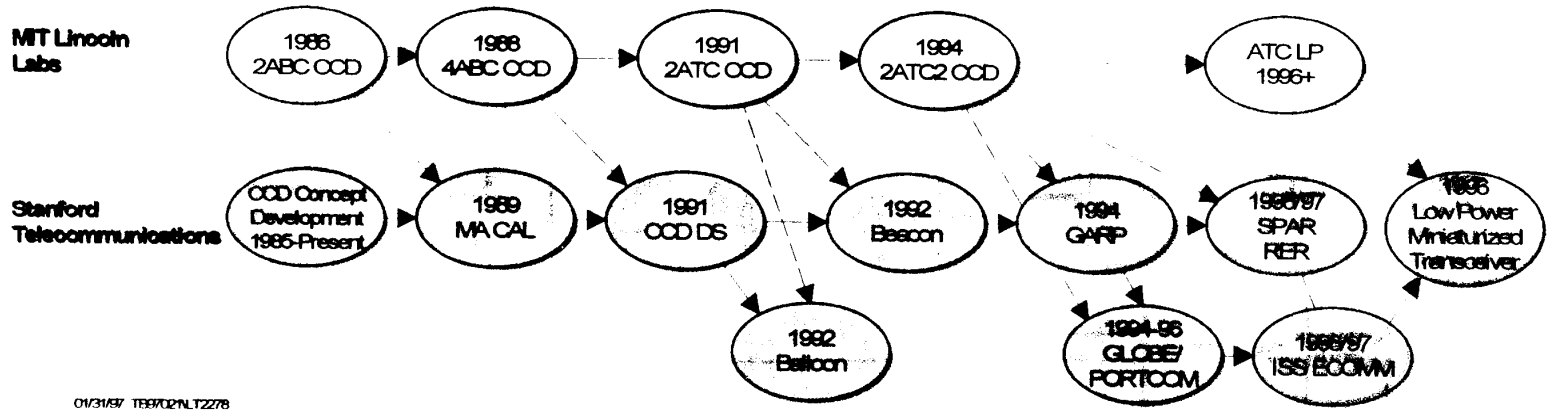


Motorola Unit

MO&DS Directorate

Code 500

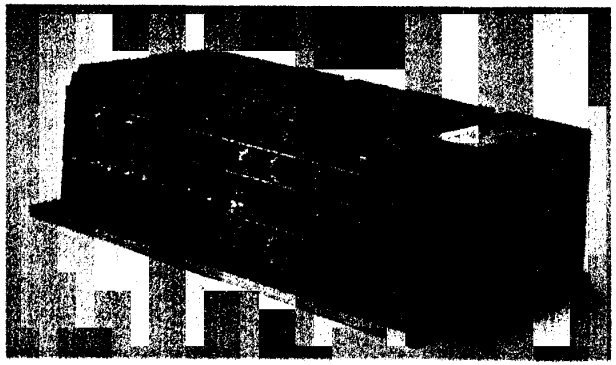
CCD-BASED RECEIVER EVOLUTION



Activity	Timeframe	Sponsor	Objectives
CCD Integrated Receiver (Phase I)	1985	NASA SBIR Program	Feasibility Study
CCD Integrated Receiver (Phase II)	1986 - 1988	NASA SBIR Program	Laboratory Proof of Concept
TDRSS MA Calibration Receiver	1988 - 1990	NASA/GSFC TDRSS Ground Ops	Operational Ground Receiver
CCD Receiver Demonstration System	1989 - 1993	NASA/HQ Code O & Code 531: Advanced Systems	Testbed for Advanced CCD Receiver Development
TDRSS Balloon-Class User Transponder	1991-1994	NASA/HQ Code O & Code 531: Advanced Systems	Operational Flight Units
TDRSS Lab Prototype Receiver (Build 1) (Beacon Receiver)	1992 - 1994	NASA/HQ Code O & Code 531: Advanced Systems	Proof of Concept; Numerous TDRSS/GN Demos
TDRSS Lab Prototype Receiver (Build 2) (GN Advanced Receiver Prototype)	1994 - 1996	NASA/HQ Code O & Code 531: Advanced Systems	Proof of Concept; Subset of RER Functions (including Shuttle)
GLOBE/Portcom	1994 - 1996	NASA/HQ Code O: Space Network	10 Field-Deployable Demonstration Units; Basis for Potential Miniaturization
Software Programmable Advanced Receiver	1996 -	NASA/HQ Code O & Code 531: Advanced Systems	Subset of RER functions, including carrier- and subcarrier-tone ranging
ISS ECOMM	1996 - 97	NASA/HQ Code Q & Code 500	International Space Station Early Communications Support

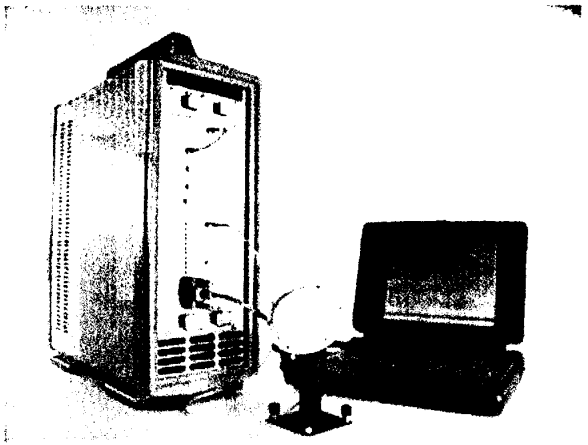
OTHER SUCCESSFUL TECHNOLOGY DEVELOPMENTS

TURFTS



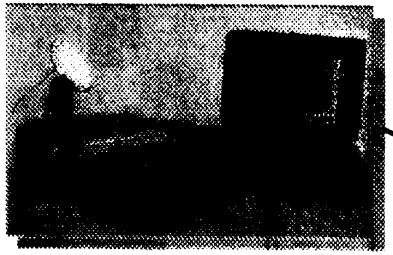
Balloon-class TDRSS User Transponder

PORTCOM Receiver



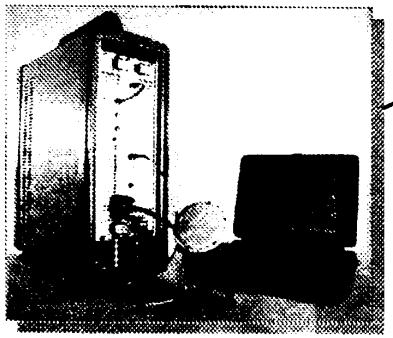
PORTCOM Transmitter

CCD Receiver Signal Processing Technology



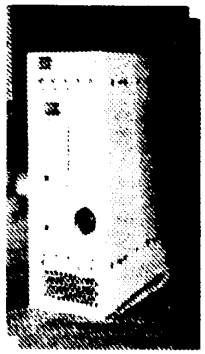
PORTCOM Transmitter

- ❑ 1 Watt
- ❑ ≤ 9.6 KBPS
- ❑ Integrated GPS



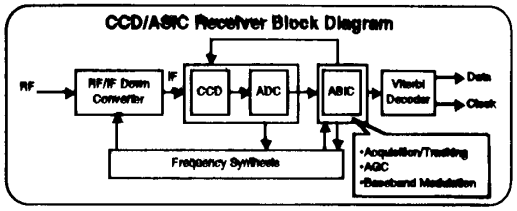
PORTCOM Receiver

≤ 9.6 KBPS

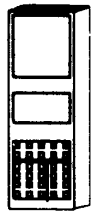


ECOMM Transceiver for Space Station ≤128 KBPS

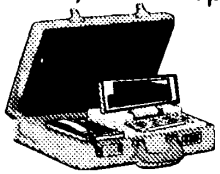
Possible Next Generation TDRSS Customer Terminals



PCMCIA Card for Laptop

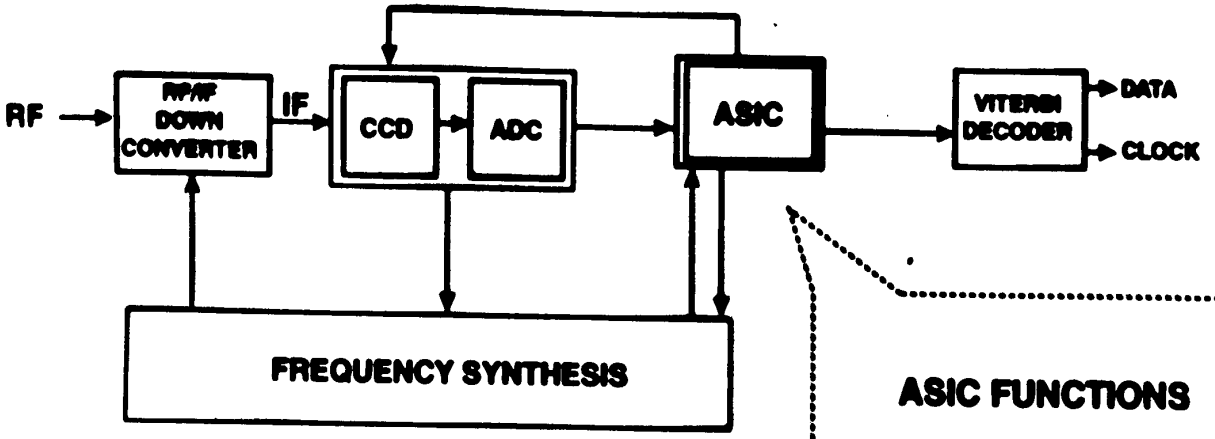


Miniaturized Transmitter, Transceiver, or Transponder



Portable (e.g., Attaché Case) Transceiver

CCD/ASIC Based Receiver Block Diagram



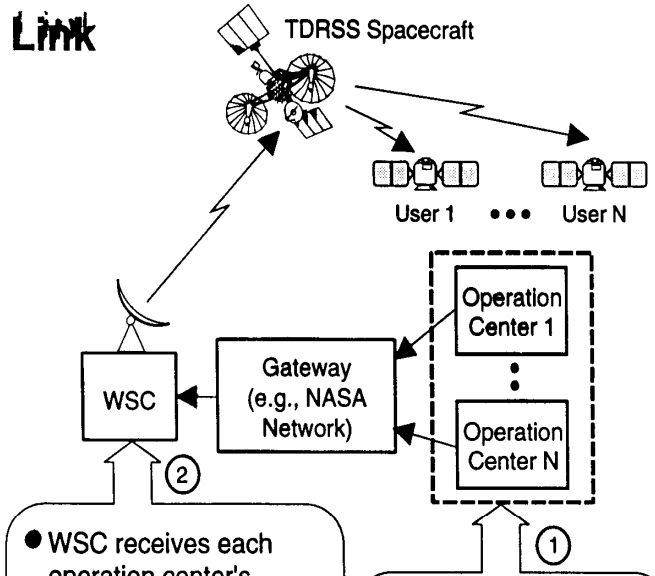
ASIC FUNCTIONS

- PN Acquisition / Tracking
- Carrier Acquisition / Tracking
- Symbol Synchronization
- AGC
- PN Code Generation
- Baseband Modulation

Technology Utilization Committee Communications

Demand Access via Innovative Application of MA Forward and Return Services

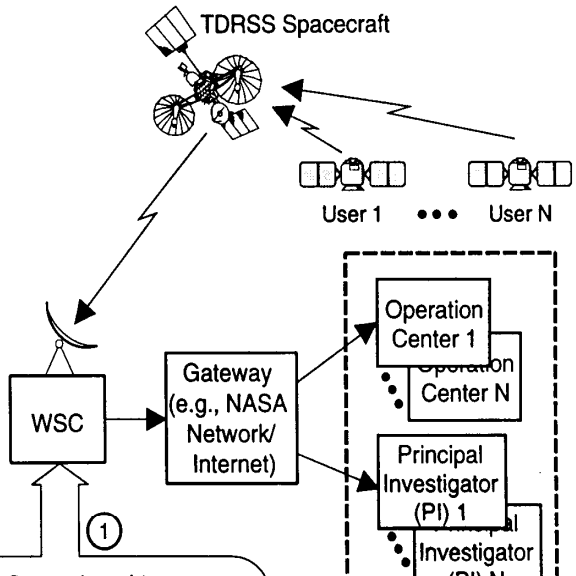
Forward Link



- WSC receives each operation center's data stream, configures link, and transmits data to designated user via TDRS
- Minimal contention and delay

- User operation center send commands/ messages to WSC for immediate broadcast to user satellite
- No prior scheduling

Return Link



- WSC receives/detects random access transmissions from user satellites
- WSC immediately routes data to individual users

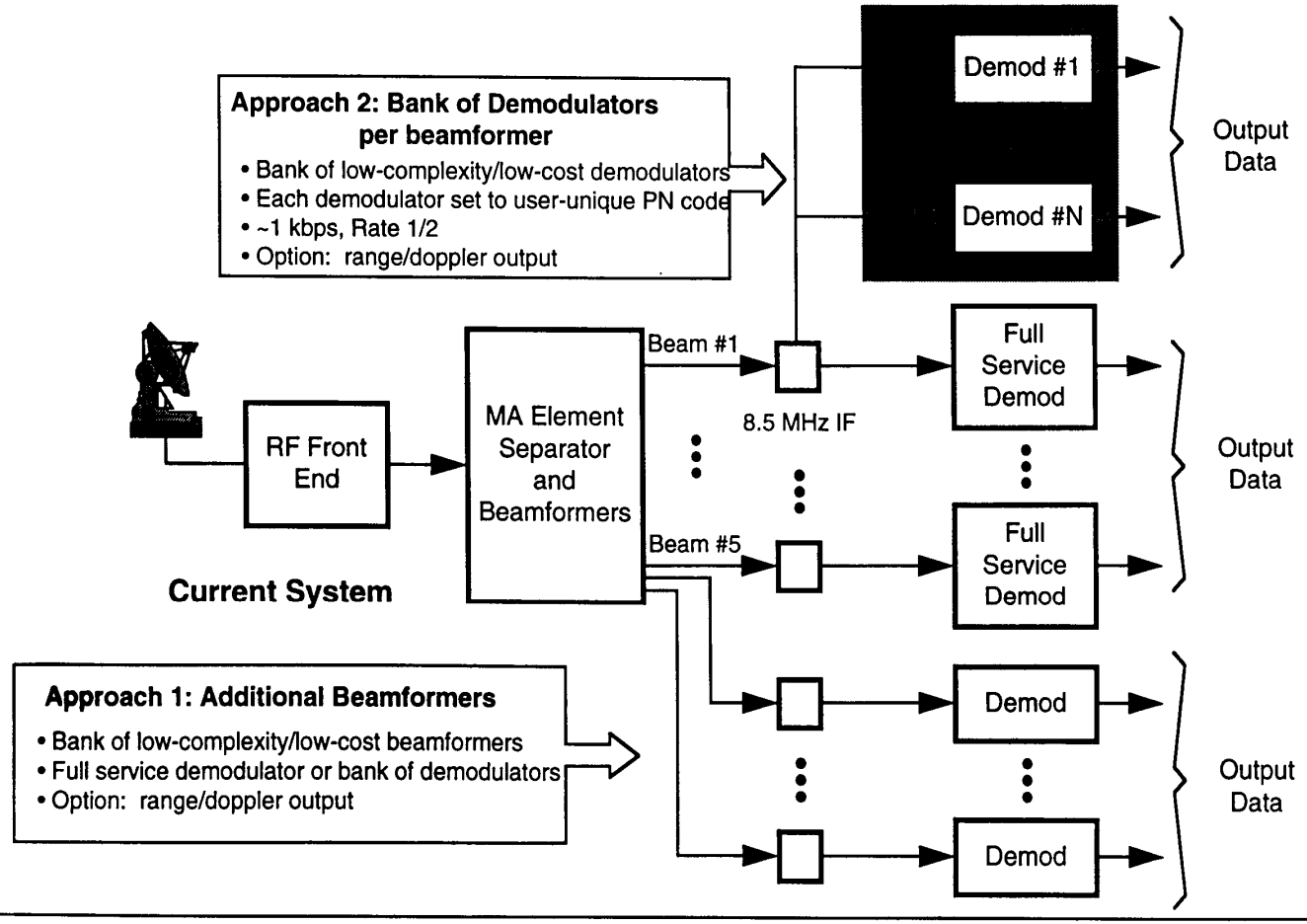
Operation centers and PIs receive return data in real-time

Demand Access Technology Development

- Low-cost Demods - Spin-off of CCD-based receiver developments
- Low-Cost MA Beamformer - Trade study assessed design concepts/ approaches to increasing the level of circuit integration and reducing the size, complexity and production and life cycle costs

Technology Utilization Committee Communications

Low-Cost MA Return Demand Access Hardware Configuration



REFERENCE ARCHITECTURE FOR: THIRD GENERATION BF SUBSYSTEM (TGBFS)